IS/IEC 60947-3 (1999): Lowpvoltage switchgear and controlgear, Part 3: Switches, disconnectors, switch-disconnectors and fuse combination units [ETD 7: Low Voltage Switchgear and Controlgear]

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IS/IEC 60947-3 : 1999
[Superseding IS 13947 (Part 3) : 1993]

भारतीय मानक

निम्न-वोल्टता के स्विचगियर और नियंत्रणगियर

भाग 3 स्विच, वियोजक, स्विच वियोजक और फ्यूज़ संयोजक इकाईयाँ

Indian Standard

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR

PART 3 SWITCHES, DISCONNECTORS, SWITCH-DISCONNECTORS AND FUSE COMBINATION UNITS

ICS 29.120.40; 29.130.20

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Price Group 14

Low-Voltage Switchgear and Controlgear Sectional Committee, ETD 07

NATIONAL FOREWORD

This Indian Standard (Part 3) which is identical with IEC 60947-3 : 1999 'Low-voltage switchgear and controlgear — Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Low-Voltage Switchgear and Controlgear Sectional Committee and approval of the Electrotechnical Division Council.

This standard is a consolidated version of IEC 60947-3 : 1999 incorporating Amendment Nos. 1 and 2 published in 2001 and 2005 respectively, along with its Corrigendum 1 in July 1999 and Corrigendum 1 to Amendment No. 1 in August 2001.

This standard supersedes IS 13947 (Part 3) : 1993 'Specification for low-voltage switchgear and controlgear: Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination unit'.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60050 (441) (1984) International Electrotechnical Vocabulary (IEV) — Chapter 441: Switchgear, controlgear and fuses	IS 1885 (Part 17) : 1979 Electrotechnical vocabulary: Part 17 Switchgear and controlgear (*first revision*)	Technically Equivalent
IEC 60269-1 (1986) Low-voltage fuses — Part 1: General requirements	IS 13703 (Part 1) : 1993 Low-voltage fuses for voltages not exceeding 1 000 V ac or 1 500 V dc: Part 1 General requirements	Identical
IEC 60269-2 (1986) Low-voltage fuses — Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)	IS 13703 (Part 2/Sec 1) : 1993 Low-voltage fuses for voltages not exceeding 1 000 V ac or 1 500 V dc: Part 2 Fuses for use by authorized persons, Section 1 Supplementary requirements	do
IEC 60269-2-1 (1987) Low-voltage fuses — Part 2-1: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) — Sections I to V: Examples of types of standardized fuses	IS 13703 (Part 2/Sec 2) : 1993 Low-voltage fuses for voltages not exceeding 1 000 V ac or 1 500 V dc: Part 2 Fuses for use by authorized persons, Section 2 Examples of standardized fuses	do

International Standard	Corresponding Indian Standard	Degree of Equivalence
IEC 60410 (1973) Sampling plans and procedures for inspection by attributes	IS 10673 : 1983 Sampling plans and procedures for inspection by attributes for electronic items	Technically Equivalent
IEC 60417 (2002) Graphical symbol for use on equipment IEC 60617-7 (2001) Graphical symbols for diagrams	IS 12032 (Part 7) : 1987 Graphical symbols for diagrams in the field of electrotechnology: Part 7 Switchgear, controlgear and protective devices	do
IEC 60947-1 (2004) Low-voltage switchgear and controlgear — Part 1: General rules	IS/IEC 60947 (Part 1) : 2004 Low-voltage switchgear and controlgear: Part 1 General rules	Identical
IEC 60947-2 (2003) Low-voltage switchgear and controlgear — Part 2: Circuit-breakers	IS/IEC 60947 (Part 2) : 2003 Low-voltage switchgear and controlgear: Part 2 Circuit breakers	do
IEC 60947-4-1 (2002) Low-voltage switchgear and controlgear — Part 4: Contactors and motor-starters — Section 1: Electromechanical contactors and motor-starters	IS/IEC 60947 (Part 4/Sec 1) : 2002 Low-voltage switchgear and controlgear: Part 4 Contactors and motor-starters, Section 1 Electromechanical contactors and motor-starters	do
IEC 60947-5-1 (2003) Low-voltage switchgear and controlgear — Part 5: Control circuit devices and switching elements — Section 1: Electromechanical control circuit devices	IS/IEC 60947 (Part 5/Sec 1) : 2003 Low-voltage switchgear and controlgear: Part 5 Control circuit devices and switching elements, Section 1 Electromechanical control circuit devices	do
IEC 61000-4-2 (1995) Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test	IS 14700 (Part 4/Sec 2) : 1999 Electromagnetic compatibility (EMC): Part 4 Testing and measurement techniques, Section 2 Electrostatic discharge immunity test	do
IEC 61000-4-3 (2002) Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 3: Radiated, radio-frequency, electromagnetic field immunity test	IS 14700 (Part 4/Sec 3) : 2005 Electromagnetic compatibility (EMC): Part 4 Testing and measurement techniques, Section 3 Radiated, radio-frequency, electromagnetic field immunity test	do
IEC 61000-4-4 (1995) Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 4: Electrical fast transient/burst immunity test	IS 14700 (Part 4/Sec 4) : 1999 Electromagnetic compatibility (EMC): Part 4 Testing and measurement techniques, Section 4 Electrical fast transient/burst immunity test	do
CISPR 11 (1997) Industrial, scientific and medical (ISM) radio-frequency equipment — Electromagnetic disturbance characteristics — Limits and methods of measurement	IS 6873 (Part 4) : 1999 Limits and methods of measurement of radio disturbance characteristics: Part 4 Industrial, scientific and medical (ISM) radio-frequency equipment (*first revision*)	do
CISPR 22 (1997) Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement	IS 6873 (Part 7) : 1999 Limits and methods of measurement of radio disturbance characteristics: Part 7 Information technology equipment (*first revision*)	do

The technical committee responsible for the preparation of this standard has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
IEC 61000-4-5 (1995)	Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 5: Surge immunity test
IEC 61000-4-6 (1996)	Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 6: Immunity to conducted disturbances, induced by radio frequency fields
IEC 60447(2004)	Basic and safety principles for man-machine interface (marking and identification) — Actuating principles

Only the English text of the International Standard has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Indian Standard

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR

PART 3 SWITCHES, DISCONNECTORS, SWITCH-DISCONNECTORS AND FUSE COMBINATION UNITS

1 General

The provisions of the general rules dealt with in IEC 60947-1 are applicable to this standard, where specifically called for. Clauses and subclauses, tables, figures and appendices of the general rules thus applicable are identified by reference IEC 60947-1, e.g., 4.3.4.1 of IEC 60947-1, Table 4 IEC 60947-1, or annex A of IEC 60947-1.

1.1 Scope and object

This standard applies to switches, disconnectors, switch-disconnectors and fuse-combination units to be used in distribution circuits and motor circuits of which the rated voltage does not exceed 1 000 V a.c. or 1 500 V d.c.

The manufacturer shall specify the type, ratings and characteristics according to the relevant standard of any incorporated fuses.

This standard does not apply to equipment coming within the scope of IEC 60947-2, IEC 60947-4-1 and IEC 60947-5-1; however, when switches and fuse-combination units coming into the scope of this standard are normally used to start, accelerate and/or stop an individual motor they shall also comply with the additional requirements given in annex A.

The requirements for single pole operated three pole switches are included in Annex C.

Auxiliary switches fitted to equipment within the scope of this standard shall comply with the requirements of IEC 60947-5-1.

This standard does not include the additional requirements necessary for electrical apparatus for explosive gas atmospheres.

NOTE 1 Depending on its design, a switch (or disconnector) can be referred to as "a rotary switch (disconnector)", "cam-operated switch (disconnector)", "knife-switch (disconnector)", etc.

NOTE 2 In this standard, the word "switch" also applies to the apparatus referred to in French as "commutateurs", intended to modify the connections between several circuits and *inter alia* to substitute a part of a circuit for another.

NOTE 3 In general, throughout this standard switches, disconnectors, switch-disconnectors and fuse-combination units will be referred to as "equipment".

The object of this standard is to state

a) the characteristics of the equipment;

b) the conditions with which the equipment shall comply with reference to

   1) operation and behaviour in normal service;

   2) operation and behaviour in case of specified abnormal conditions, e.g. short circuit;

   3) dielectric properties;

c) the tests for confirming that these conditions have been met and the methods to be adopted for these tests;

d) the information to be marked on the equipment or made available by the manufacturer, e.g. in the catalogue.

1.2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(441):1984, *International Electrotechnical Vocabulary (IEV), Chapter 441: Switchgear, controlgear and fuses*
Amendment 1 (2000)

IEC 60269 (all parts), *Low-voltage fuses*

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 60417-DB:2002[1], *Graphical symbols for use on equipment*

IEC 60447:2004, *Basic and safety principles for man-machine interface, marking and identification – Actuating principles*

IEC 60617-DB:2001[1], *Graphical symbols for diagrams*

IEC 60947-1:2004, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-2:2003, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-4-1:2000, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*
Amendment 1 (2002)

IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test. Basic EMC Publication*
Amendment 1 (1998)
Amendment 2 (2000)

IEC 61000-4-3:2002, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated radio-frequency electromagnetic field immunity test*
Amendment 1 (2002)

IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*
Amendment 1 (2000)

IEC 61000-4-6:2003, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

CISPR 11:2003, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*

[1] "DB" refers to the IEC on-line database.

CISPR 22:2003, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

2 Definitions

For the purposes of this part of IEC 60947, the definitions given in IEC 60050(441), IEC 60947-1 and the following apply

2.1
switch (mechanical)
a mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short-circuit.

NOTE A switch may be capable of making, but not breaking, short-circuit currents.

[IEV 441-14-10]

2.2
disconnector
a mechanical switching device which, in the open position, complies with the requirements specified for the isolating function.

NOTE 1 This definition differs from IEV 441-14-05 by referring to isolating function instead of isolating distance.

NOTE 2 A disconnector is capable of opening and closing a circuit when either a negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.

2.3
switch-disconnector
a switch which, in the open position, satisfies the isolating requirements specified for a disconnector

[IEV 441-14-12]

2.4
fuse-combination unit
a combination of a mechanical switching device and one or more fuses in a composite unit, assembled by the manufacturer or in accordance with his instructions

[IEV 441-14-04]

NOTE (Not included in IEV 441-14-04.) This is a general term for fuse switching devices (see also definitions 2.5 to 2.10 and Table 1)

2.5
switch-fuse
a switch in which one or more poles have a fuse in series in a composite unit

[IEV 441-14-14]

2.6
fuse-switch
a switch in which a fuse-link or a fuse-carrier with fuse-link forms the moving contact

[IEV 441-14-17]

2.7
disconnector-fuse
a disconnector in which one or more poles have a fuse in series in a composite unit

[IEV 441-14-15]

2.8
fuse-disconnector
a disconnector in which a fuse-link or fuse-carrier with fuse-link forms the moving contact

[IEV 441-14-18]

2.9
switch-disconnector-fuse
a switch-disconnector in which one or more poles have a fuse in series in a composite unit

[IEV 441-14-16]

2.10
fuse-switch-disconnector
a switch-disconnector in which a fuse-link or a fuse-carrier with fuse-link forms the moving contact

[IEV 441-14-19]

2.11
single pole operated three pole switch
device consisting of three individually operable single pole switch disconnecting devices according to this standard, rated as a complete unit for use in a three-phase system

NOTE These devices are intended for power distribution systems where switching and/or isolation of an individual phase may be necessary and they should not be used for the switching of the primary circuit of three-phase equipment.

2.12
multiple tip contact system
a multiple tip contact system consists of more than one contact gap per pole, which can be switched, in series and/or in parallel

2.13
dependent manual operation (of a mechanical switching device)
an operation solely by means of directly applied manual energy such that the speed and force of the operation are dependent upon the action of the operator

[IEV 441-16-13]

2.14
independent manual operation (of a mechanical switching device)
a stored energy operation where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator

[IEV 441-16-16]

2.15
semi-independent manual operation
an operation solely by means of directly applied manual energy such that the manual force is increased up to a threshold value beyond which the independent switching operation is achieved unless deliberately delayed by the operator.

2.16
stored energy operation (of a mechanical switching device)
an operation by means of energy stored in the mechanism itself prior to the completion of the operation and sufficient to complete it under predetermined conditions

[IEV 441-16-15]

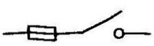
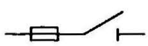
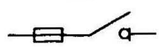
NOTE This kind of operation may be subdivided according to:

a) the manner of storing the energy (spring, weight, etc.);

b) the origin of the energy (manual, electric, etc.);

c) the manner of releasing the energy (manual, electric, etc.).

Table 1 – Summary of equipment definitions

Function		
Making and breaking current	**Isolating**	**Making, breaking and isolating**
Switch 2.1 	Disconnector 2.2 	Switch-disconnector 2.3 
Fuse combination unit 2.4		
Switch-fuse 2.5 a) 	Disconnector-fuse 2.7 a) 	Switch-disconnector-fuse 2.9 a) 
Fuse-switch 2.6 	Fuse-disconnector 2.8 	Fuse-switch disconnector 2.10 
NOTE 1 All equipment may be single-break or multi-break. NOTE 2 Numbers are subclause references of the relevant definitions. NOTE 3 Symbols are based on IEC 60617-7.		
[a] The fuse may be on either side of or in a stationary position between the contacts of the equipment.		

3 Classification

3.1 According to the utilization category

See 4.4.

3.2 According to the method of operation of manually operated equipment

- dependent manual operation (see 2.13);
- independent manual operation (see 2.14);
- semi-independent manual operation (see 2.15).

NOTE The method of operation on closing may be different from the method for opening.

3.3 According to suitability for isolation

- suitable for isolation (see 7.1.6 of IEC 60947-1 and 7.1.6.1);
- not suitable for isolation.

3.4 According to the degree of protection provided

See 7.1.11 of IEC 60947-1.

4 Characteristics

4.1 Summary of characteristics

The characteristics of the equipment shall be stated in terms of the following as applicable.

- type of equipment (see 4.2);
- rated and limiting values for the main circuit (see 4.3);
- utilization category (see 4.4);
- control circuits (see 4.5);
- auxiliary circuits (see 4.6);

4.2 Type of equipment

The following shall be stated.

4.2.1 Number of poles

4.2.2 Kind of current

Kind of current (a.c. or d.c.) and, in the case of a.c., number of phases and rated frequency.

4.2.3 Number of positions of the main contacts (if more than two)

4.3 Rated and limiting values for the main circuit

Rated values are assigned by the manufacturer. They shall be stated in accordance with 4.3.1 to 4.3.6.4 but it may not be necessary to establish all the rated values listed.

4.3.1 Rated voltages

An equipment is defined by the following rated voltages.

4.3.1.1 Rated operational voltage (U_e)

Subclause 4.3.1.1 of IEC 60947-1 applies.

4.3.1.2 Rated insulation voltage (U_i)

Subclause 4.3.1.2 of IEC 60947-1 applies.

4.3.1.3 Rated impulse withstand voltage (U_{imp})

Subclause 4.3.1.3 of IEC 60947-1 applies.

4.3.2 Currents

An equipment is defined by the following currents:

4.3.2.1 Conventional free air thermal current (I_{th})

Subclause 4.3.2.1 of IEC 60947-1 applies.

4.3.2.2 Conventional enclosed thermal current (I_{the})

Subclause 4.3.2.2 of IEC 60947-1 applies.

4.3.2.3 Rated operational currents (I_e) (or rated operational powers)

Subclause 4.3.2.3 of IEC 60947-1 applies.

4.3.2.4 Rated uninterrupted current (I_u)

Subclause 4.3.2.4 of IEC 60947-1 applies.

4.3.3 Rated frequency

Subclause 4.3.3 of IEC 60947-1 applies.

4.3.4 Rated duty

The rated duties considered as normal are as follows.

4.3.4.1 Eight-hour duty

Subclause 4.3.4.1 of IEC 60947-1 applies.

4.3.4.2 Uninterrupted duty

Subclause 4.3.4.2 of IEC 60947-1 applies.

4.3.5 Normal load and overload characteristics

4.3.5.1 Ability to withstand motor switching overload currents

See annex A.

4.3.5.2 Rated making capacity

Subclause 4.3.5.2 of IEC 60947-1 applies with the following additions.

The rated making capacity is stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table 3.

Not applicable to AC-20 or DC-20 equipment.

4.3.5.3 Rated breaking capacity

Subclause 4.3.5.3 of IEC 60947-1 applies with the following additions.

The rated breaking capacity is stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table 3.

Not applicable to AC-20 or DC-20 equipment.

4.3.6 Short-circuit characteristics

4.3.6.1 Rated short-time withstand current (I_{cw})

The rated short-time withstand current of a switch, a disconnector or a switch-disconnector is the value of short-time withstand current, assigned by the manufacturer, that the equipment can carry without any damage under the test conditions of 8.3.5.1.

The value of the rated short-time withstand current shall be not less than twelve times the maximum rated operational current and, unless otherwise stated by the manufacturer, the duration of the current shall be 1 s.

For a.c., the value of the current is the r.m.s. value of the a.c. component and it is assumed that the highest peak value likely to occur does not exceed n times this r.m.s. value, the factor n being given by Table 16 of IEC 60947-1.

4.3.6.2 Rated short-circuit making capacity (I_{cm})

The rated short-circuit making capacity of a switch or a switch-disconnector is the value of short-circuit making capacity assigned to the equipment by the manufacturer for the rated operational voltage, at rated frequency (if any) and at a specified power-factor (or time-constant). It is expressed as the maximum prospective peak current.

For a.c., the relationship between power-factor, prospective peak current and r.m.s. current shall be in accordance with Table 16 of IEC 60947-1.

Not applicable to AC-20 or DC-20 equipment.

4.3.6.3 Vacant

4.3.6.4 Rated conditional short-circuit current

Subclause 4.3.6.4 of IEC 60947-1 applies.

4.4 Utilization category

The utilization categories define the intended applications and are given in Table 2.

Each utilization category is characterized by the values of the currents and voltages, expressed as multiples of the rated operational current and the rated operational voltage, as well as the power-factors or time-constants of the circuit. The conditions for making and breaking given in Table 3 correspond in principle to the applications listed in Table 2.

The designation of utilization categories is completed by the suffix A or B according to whether the intended applications require frequent or infrequent operations (see Table 4).

Utilization categories with suffix B are appropriate for devices which, due to design or application, are only intended for infrequent operation. This could apply, for example, to disconnectors normally only operated to provide isolation for maintenance work or switching devices where the fuse-link blade forms the moving contact.

The distinction between frequent and infrequent operation is based on the manufacturer's rated operation and the number of operating cycles used as a test criterion in Table 4.

For a particular rated operational current I_e, a device will be designated for frequent use (category A) if the manufacturer's rated operating life is more than the number of operating cycles indicated in columns 3, 4 or 5 of Table 4.

Table 2 – Utilization categories

Nature of current	Utilization category		Typical applications
	Category A	Category B	
Alternating current	AC-20A *	AC-20B *	– Connecting and disconnecting under no-load conditions
	AC-21A	AC-21B	– Switching of resistive loads including moderate overloads
	AC-22A	AC-22B	– Switching of mixed resistive and inductive loads, including moderate overloads
	AC-23A	AC-23B	– Switching of motor loads or other highly inductive loads
Direct current	DC-20A*	DC-20B*	– Connecting and disconnecting under no-load conditions
	DC-21A	DC-21B	– Switching of resistive loads including moderate overloads
	DC-22A	DC-22B	– Switching of mixed resistive and inductive loads, including moderate overloads (e.g. shunt motors)
	DC-23A	DC-23B	– Switching of highly inductive loads (e.g. series motors)

* The use of these utilization categories is not permitted in the United States of America.

Category AC-23 includes occasional switching of individual motors. The switching of capacitors or of tungsten filament lamps shall be subject to agreement between manufacturer and user.

The utilization categories referred to in Tables 2 and 3 do not apply to an equipment normally used to start, accelerate and/or stop individual motors. The utilization categories for such an equipment are dealt with in annex A.

4.5 Control circuits

Subclause 4.5 of IEC 60947-1 applies.

4.6 Auxiliary circuits

Subclause 4.6 of IEC 60947-1 applies.

4.7 Relays and releases

Subclause 4.7 of IEC 60947-1 applies.

5 Product information

5.1 Nature of information

Subclause 5.1 of IEC 60947-1 applies as appropriate for a particular design.

5.2 Marking

5.2.1 Each equipment shall be marked in a durable and legible manner with the following data.

The markings for a), b) and c) below shall be on the equipment itself or on a name-plate or name-plates attached to the equipment, and shall be located at a place such that they are legible from the front after mounting the equipment in accordance with the manufacturer's instructions.

a) Indication of the open and closed position. The open and closed position shall be respectively indicated by the graphical symbols 60417-IEC-5007 and 60417-IEC-5008 of IEC 60417-2 (see 7.1.5.1 of IEC 60947-1).

b) Suitability for isolation

The appropriate symbols of Table 1 shall be used.

c) Additional marking for disconnectors

Devices of utilization category AC-20A, AC-20B, DC-20A and DC-20B shall be marked "Do not operate under load", unless the device is interlocked to prevent such operation.

NOTE Symbols of the various types of equipment are given in Table 1.

5.2.2 The following data shall also be marked on the equipment but need not be visible from the front when the equipment is mounted:

a) manufacturer's name or trade mark;

b) type designation or serial number;

c) rated operational currents (or rated powers) at the rated operational voltage and utilization category (see 4.3.1, 4.3.2 and 4.4);

d) value (or range) of the rated frequency or the indication "d.c." (or the symbol ⎓);

e) for fuse-combination units, the fuse type and maximum rated current and the power loss of the fuse-link;

f) IEC 60947-3, if the manufacturer claims compliance with this standard;

g) degree of protection of enclosed equipment (see annex C of IEC 60947-1).

5.2.3 The following terminals shall be identified:

a) line and load terminals unless the connection is immaterial (see 8.3.3.3.1);

b) neutral pole terminal, if applicable, by the letter "N" (see 7.1.7.4 of IEC 60947-1);

c) protective earth terminal (see 7.1.9.3 of IEC 60947-1).

5.2.4 The following data shall be made available in the manufacturer's published information:

a) rated insulation voltage;

b) rated impulse withstand voltage for equipment suitable for isolation or when determined;

c) pollution degree, if different from 3;

d) rated duty;

e) rated short-time withstand current and duration, where applicable;

f) rated short-circuit making capacity, where applicable;

g) rated conditional short-circuit current,.where applicable.

5.3 Instructions for installation, operation and maintenance

Subclause 5.3 of IEC 60947-1 applies.

6 Normal service, mounting and transport conditions

Clause 6 of IEC 60947-1 applies with the following addition.

Pollution degree (see 6.1.3.2 of IEC 60947-1).

Unless otherwise stated by the manufacturer, the equipment is intended for installation under environmental conditions of pollution degree 3.

7 Constructional and performance requirements

7.1 Constructional requirements

Subclause 7.1 of IEC 60947-1 applies, with the following additions.

7.1.1 Materials

The suitability of materials used shall be verified with respect to resistance to abnormal heat and fire by conducting tests:

a) on the equipment; or

b) on sections taken from the equipment; or

c) on samples of identical material having a representative cross-section.

If an identical material having a representative cross-section has already satisfied the requirements, then those tests need not be repeated.

7.1.1.1 Resistance to abnormal heat and fire

Subclause 7.1.1.1 of IEC 60947-1 applies with the following additions.

Parts of insulating material necessary to retain current-carrying parts in position shall conform to the glow-wire tests of 8.2.1.1.1 of IEC 60947-1 at a test temperature of 960 °C.

When tests are conducted on material manufacturers samples according to 7.1.1c), they shall be made according to the tests for flammability and hot wire corresponding to a glow-wire test of 960 °C as specified in 8.2.1.1.2, and annex M of IEC 60947-1.

7.1.3 Clearances and creepage distances

Subclause 7.1.3 of IEC 60947-1 applies with the following addition:

Guidance on the measurement of clearances and creepage distances is given in annex G of IEC 60947-1.

7.1.4 Actuator

Subclause 7.1.4 of IEC 60947-1 applies.

7.1.6 Additional requirements for equipment suitable for isolation

Subclause 7.1.6 of IEC 60947-1 applies with the following additions.

7.1.6.1 Additional constructional requirements for equipment suitable for isolation

The equipment shall be marked according to 5.2.1b).

When no indication of the position of the contacts is provided, for example by the actuator or a separate indicator, all the main contacts shall be clearly visible in the open position.

The strength of the actuating mechanism and the reliability of the indication of the open position shall be checked according to 8.2.5. Moreover, when means are provided by the manufacturer to lock the equipment in the open position, locking shall only be possible when the main contacts are in the open position (see 8.2.5).

This requirement does not apply to equipment where the main contact position is visible in the open position and/or the open position is indicated by other means than the actuator.

NOTE Locking in the closed position is permitted for particular applications.

The clearance across the open contacts of the same pole when in the open position shall not be less than the minimum clearance given in Table 13 of IEC 60947-1 and shall also comply with the requirements of 7.2.3.1b) of IEC 60947-1.

7.1.6.2 Supplementary requirements for equipment with provision for electrical interlocking with contactors or circuit-breakers

If equipment suitable for isolation is provided with an auxiliary switch for the purpose of electrical interlocking with contactor(s) or circuit-breaker(s) and intended to be used in motor circuits, the following requirements shall apply unless the equipment is rated for AC-23 utilization category.

An auxiliary switch shall be rated according to IEC 60947-5-1 as stated by the manufacturer.

The time interval between the opening of the contacts of the auxiliary switch and the contacts of the main poles shall be sufficient to ensure that the associated contactor or circuit-breaker interrupts the current before the main poles of the equipment open.

Unless otherwise stated in the manufacturer's technical literature, the time interval shall be not less than 20 ms when the equipment is operated according to the manufacturer's instructions.

Compliance shall be verified by measuring the time interval between the instant of opening of the auxiliary switch and the instant of opening of the main poles under no-load conditions when the equipment is operated according to the manufacturer's instructions.

During the closing operation the contacts of the auxiliary switch shall close after or simultaneously with the contacts of the main poles.

A suitable opening time interval may also be provided by an intermediate position (between the ON and OFF positions) at which the interlocking contact(s) is (are) open and the main poles remain closed.

7.1.6.3 Supplementary requirements for equipment provided with means for padlocking the open position

The locking means shall be designed in such a way that it cannot be removed with the appropriate padlock(s) installed. When the equipment is locked by even a single padlock, it shall not be possible by operating the actuator, to reduce the clearance between open contacts to the extent that it no longer complies with the requirements of 7.2.3.1b) of IEC 60947-1.

Alternatively, the design may provide padlockable means to prevent access to the actuator.

Compliance with the requirements to padlock the actuator shall be verified using a padlock specified by the manufacturer or an equivalent gauge, giving the most adverse conditions, to simulate locking. The force *F*, specified in 8.2.5.2 shall be applied to the actuator in an attempt to operate the equipment from the open position to the closed position. Whilst the force *F* is applied, the equipment shall be subjected to a test voltage across open contacts. The equipment shall be capable of withstanding the test voltage required according to Table 14 of IEC 60947-1 appropriate to the rated impulse withstand voltage.

7.1.8 Additional requirements for equipment provided with a neutral pole

Subclause 7.1.8 of IEC 60947-1 applies except for the note referring to an overcurrent release.

7.1.11 Degrees of protection of enclosed equipment

Degrees of protection of enclosed equipment and relevant tests are given in annex C of IEC 60947-1.

7.2 Performance requirements

7.2.1 Operating conditions

7.2.1.1 General

Subclause 7.2.1.1 of IEC 60947-1 applies with the following additions.

The following requirements apply to fuse switches, fuse disconnectors and fuse switch disconnectors with a rated short-circuit making capacity exceeding 10 kA and for which the closing operation is by direct manual operation without an interposing mechanism (dependent and semi-independent manual operation see 2.13 and 2.15).

The test speed for the making operations specified in 8.3.6.2 shall be determined as follows

a) The equipment shall be operated 15 times manually under no-load conditions in accordance with the manufacturer's instructions, five times by each of three persons. The velocity of the hand actuator at the instant of contact closure of the last closing contact shall be determined by oscillographic or other appropriate means at any convenient part of the device.

   The point at which the measurement is made and the velocity at the measurement point shall be stated in the test report. The mean velocity shall be determined after deleting the highest and lowest values.

b) The test apparatus shall ensure that the equipment under test fully closes and that there is no impediment to the free closing movement of the device. The actual test speed shall not exceed the mean velocity determined according to a).

The mass of the moving parts of the test apparatus (without the equipment under test) shall be 2 kg ± 10 %.

7.2.2 Temperature rise

Subclause 7.2.2 of IEC 60947-1 applies with the following addition.

For fuse-combination units, the temperature rise of the fuse-link contacts during the test according to 8.3.3.1 shall not cause any damage of a nature which impairs the subsequent performance of the equipment in test sequence I.

7.2.3 Dielectric properties

Subclause 7.2.3 of IEC 60947-1 applies with the following additions.

7.2.3.1 Impulse withstand voltage

Subclause 7.2.3.1 of IEC 60947-1 applies with the following addition.

Clearances across the open contacts of a device not suitable for isolation shall withstand the test voltage given in Table 12 of IEC 60947-1 appropriate to the rated impulse withstand voltage.

7.2.3.2 Power-frequency withstand voltage of the main, auxiliary and control circuits

Subclause 7.2.3.2 c) of IEC 60947-1 applies with the following addition.

For equipment suitable for isolation, maximum values of leakage current are specified for all the test sequences in 8.3.3.5, 8.3.4.3, 8.3.5.4, 8.3.6.4 and 8.3.7.3 respectively.

7.2.4 Ability to make and break under no-load, normal load and overload conditions

7.2.4.1 Making and breaking capacities

The rated making and breaking capacities are stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table 3.

The test conditions are specified in 8.3.3.3.1.

Table 3 – Verification of rated making and breaking capacities (see 8.3.3.3) – Conditions for making and breaking corresponding to the various utilization categories

Utilization category	Rated operational current	Making[a] I/I_e	Making U/U_e	Making cos ϕ	Breaking I_c/I_e	Breaking U_r/U_e	Breaking cos ϕ	Number of operating cycles
AC-20A[b] – AC-20B[b]	All values	–	–	–	–	–	–	
AC-21A – AC-21B	All values	1,5	1,05	0,95	1,5	1,05	0,95	5
AC-22A – AC-22B	All values	3	1,05	0,65	3	1,05	0,65	5
AC-23A – AC-23B	$0 < I_e \le 100$ A	10	1,05	0,45	8	1,05	0,45	5
	$100\text{ A} < I_e$	10	1,05	0,35	8	1,05	0,35	3
Utilization category	**Rated operational category**	I/I_e	U/U_e	L/R ms	I_c/I_e	U_r/U_e	L/R ms	**Number of operating cycles**
DC-20A[b] – DC-20B[b]	All values	–	–	–	–	–	–	
DC-21A – DC-21B	All values	1,5	1,05	1	1,5	1,05	1	5
DC-22A – DC-22B	All values	4	1,05	2,5	4	1,05	2,5	5
DC-23A – DC-23B	All values	4	1,05	15	4	1,05	15	5

I = Making current
I_c = Breaking current
I_e = Rated operational current
U = Applied voltage
U_e = Rated operational voltage
U_r = Operational frequency or d.c. recovery voltage

[a] For a.c. the making current is expressed by the r.m.s. value of the periodic component of the current.
[b] The use of these utilization categories is not permitted in the United States of America.

7.2.4.2 Operational performance

Tests concerning the verification of the operational performance of an equipment are intended to verify that the equipment is capable of making and breaking without failure, the currents flowing in its main circuit for the intended use.

The number of operating cycles and the test circuit parameters for the operational performance test for the various utilization categories are given in Tables 4 and 5.

The test conditions are specified in 8.3.4.1.

Table 4 – Verification of operational performance – Number of operating cycles corresponding to the rated operational current

1	2	3	4	5	6	7	8
Rated operational current I_e	Number of operating cycles per hour	Number of operating cycles					
		AC and DC A categories			AC and DC B categories		
		Without current	With current	Total	Without current	With current	Total
$0 < I_e \le 100$	120	8 500	1 500	10 000	1 700	300	2 000
$100 < I_e \le 315$	120	7 000	1 000	8 000	1 400	200	1 600
$315 < I_e \le 630$	60	4 000	1 000	5 000	800	200	1 000
$630 < I_e \le 2\,500$	20	2 500	500	3 000	500	100	600
$2\,500 < I_e$	10	1 500	500	2 000	300	100	400

The values in the table apply to all utilization categories except AC-20A, AC-20B, DC-20A and DC-20B. These categories shall comply with the total number of operating cycles in columns 5 or 8 without current. Column 2 gives the minimum operating rate. The operating rate for any utilization category may be increased with the consent of the manufacturer.

Table 5 – Test circuit parameters for Table 4

Utilization category		Values of the rated operational current I_e	Making[a]			Breaking		
			I/I_e	U/U_e	cos ϕ	I_c/I_e	U_r/U_e	cos ϕ
AC-21A	AC-21B	All values	1	1	0,95	1	1	0,95
AC-22A	AC-22B	All values	1	1	0,8	1	1	0,8
AC-23A	AC-23B	All values	1	1	0,65	1	1	0,65
			I/I_e	U/U_e	L/R ms	I_c/I_e	U_r/U_e	L/R ms
DC-21A	DC-21B	All values	1	1	1	1	1	1
DC-22A	DC-22B	All values	1	1	2	1	1	2
DC-23A	DC-23B	All values	1	1	7,5	1	1	7,5

I = Making current
I_c = Breaking current
I_e = Rated operational current
U = Voltage before make (Applied voltage)
U_e = Rated operational voltage
U_r = Operational frequency or d.c. recovery voltage

[a] For a.c., the making current is expressed by the r.m.s. value of the periodic component of the current.

7.2.4.3 Mechanical durability

Subclause 7.2.4.3.1 of IEC 60947-1 applies. Test conditions are specified in 8.5.1.

7.2.4.4 Electrical durability

Subclause 7.2.4.3.2 of IEC 60947-1 applies. Test conditions are specified in 8.5.2.

7.2.5 Ability to make, break or withstand short-circuit currents

The equipment shall be so constructed as to be capable of withstanding, under the conditions specified in this standard, the thermal, dynamic and electrical stresses resulting from short-circuit currents.

Short-circuit currents may be encountered during current making, current carrying in the closed position and current interruption.

The ability of the equipment to make, carry and break short-circuit currents is stated in terms of one or more of the following ratings.

a) Rated short-time withstand current (see 4.3.6.1).

b) Rated short-circuit making capacity (see 4.3.6.2).

c) Rated conditional short-circuit current (see 4.3.6.4).

7.2.6 Vacant

7.2.7 Additional performance requirements for equipment suitable for isolation

These requirements only apply to equipment with rated operational voltage greater than 50 V.

With the equipment in new condition and the contacts in the open position the equipment shall withstand the dielectric test of 8.3.3.2.

If tests according to 8.3.3.3 and 8.3.4.1 have been made, the equipment in the condition after the tests shall meet the leakage current requirements of 8.3.3.5.

7.2.8 Vacant

7.2.9 Overload requirements for equipment incorporating fuses

The main circuit of an equipment shall be capable of carrying an overload current according to 8.3.7.1 and shall not cause any damage of a nature which impairs the subsequent performance of the equipment in test sequence V.

7.3 Electromagnetic compatibility

7.3.1 Vacant

7.3.2 Immunity

7.3.2.1 Equipment not incorporating electronic circuits

Equipment within the scope of IEC 60947-3 not incorporating electronic circuits are not sensitive to electromagnetic disturbances in normal service conditions and therefore no immunity tests are required.

7.3.2.2 Equipment incorporating electronic circuits

Equipment incorporating electronic circuits (e.g. an electronic fuse-blowing indicator) shall have a satisfactory immunity to electromagnetic disturbances (see 8.4.1.2).

Table 6 – Immunity tests

Type of immunity test	Applicable basic standard	Severity level required
Electrostatic discharge	IEC 61000-4-2	Air discharge 8 kV or contact discharge 4 kV
Electromagnetic field	IEC 61000-4-3	10 V/m
Fast transient/burst	IEC 61000-4-4	2 kV
Surge	IEC 61000-4-5	2 kV (common mode) 1 kV (differential mode)
Conducted disturbances induced by RF fields	IEC 61000-4-6	10 V
NOTE A simple rectifier is not sensitive to electromagnetic disturbances in normal service conditions and does not therefore require immunity tests.		

7.3.3 Emission

7.3.3.1 Equipment not incorporating electronic circuits

For equipment not incorporating electronic circuits, electromagnetic disturbances can only be generated during occasional switching operations. The duration of disturbances is in the order of milliseconds.

The frequency, level and consequences of these emissions are considered as a part of the normal electromagnetic environment of low-voltage installations.

As a result, the requirements for electromagnetic emissions are deemed to be satisfied and no verification is necessary.

7.3.3.2 Equipment incorporating electronic circuits

Equipment incorporating electronic circuits (e.g. an electronic fuse-blowing indicator) may generate continuous electromagnetic disturbances.

Emission shall fulfil the requirements of class A, group 1 of CISPR 11 or those of class A of CISPR 22 (see 8.4.2.2).

Table 7 – Emission limits

Port	Frequency range MHz	Limits [d]	Standard
Enclosure [b]	30 to 230 [a]	30 dB (μV/m) quasi peak measured at 30 m distance [c]	CISPR 11
	230 to 1 000 [a]	37 dB (μV/m) quasi peak measured at 30 m distance [c]	Class A - Group 1
AC power	0,15 to 0,5 [a]	79 dB (μV) quasi peak 66 dB (μV) average	or
	0,5 to 5 [a]	73 dB (μV) quasi peak 60 dB (μV) average	CISPR 22
	5 to 30 [a]	73 dB (μV) quasi peak 60 dB (μV) average	Class A

[a] The lower limit shall apply at the transition frequency.
[b] Applicable only to mechanical switching devices containing parts which operate at frequencies higher than 9 kHz, e.g. microprocessors.
[c] May also be measured at a 10 m distance using the limits increased by 10 dB, or at a 3 m distance using the limits increased by 20 dB.
[d] These limits have been copied, without alteration, from CISPR 11 and CISPR 22.

These limits are given for mechanical switching devices which are used exclusively in an industrial environment. When there exists a likelihood of use outside the industrial environment, the following notice shall be included in the manufacturer's published information.

> **Caution**
>
> This is a class A product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.

However, this notice is not necessary when the emission limits given in CISPR 22, class B are fulfilled.

8 Tests

8.1 Kind of tests

8.1.1 General

Subclause 8.1.1 of IEC 60947-1 applies.

8.1.2 Type tests

Subclause 8.1.2 of IEC 60947-1 applies. Type tests are given in Table 9 of this standard.

8.1.3 Routine tests

Subclause 8.1.3 of IEC 60947-1 applies with the following additions.

8.1.3.1 General

The following tests apply:

- mechanical operation test (see 8.1.3.2)

  operation of the switch, disconnector, switch-disconnector or fuse-combination unit during manufacture and/or other routine test may take the place of the tests listed above, provided the same conditions apply and the number of operations is not less than that specified;
- dielectric test (see 8.1.3.3)

if, by the control of materials and manufacturing processes, the integrity of the dielectric properties has been proven, these tests may be replaced by sampling tests according to a recognized sampling plan (see IEC 60410).

8.1.3.2 Mechanical operation test

A test shall be made to verify the correct mechanical operation of the equipment by five closing and opening operations.

8.1.3.3 Dielectric test

The test conditions shall be in accordance with 8.3.3.4.2 of IEC 60947-1. As an alternative, the combined test according to 8.3.3.4.2, item 3), of IEC 60947-1 is allowed. The value of the test voltage shall be in accordance with that given in Table 12A of IEC 60947-1. The duration of the test shall not be less than 1 s and the test voltage shall be applied as follows:

- with the equipment in the open position, between each pair of terminals which are electrically connected together when the equipment is closed;
- with the equipment in the closed position, between each pole and the adjacent pole(s) and between each pole and the frame;
- for equipment incorporating electronic circuits connected to the main poles, with the equipment in the open position, between each pole and the adjacent pole(s) and between each pole and the frame, either on the incoming side or the outgoing side depending on the position of the electronic components.

Alternatively, disconnection of the electronic circuit(s) is permitted during dielectric tests.

8.1.4 Sampling tests

Sampling tests for clearance verification according to 8.3.3.4.3 of IEC 60947-1 are under consideration.

8.1.5 Special tests

Special tests (see 2.6.4 of IEC 60947-1) are specified in 8.5.

8.2 Type tests for constructional requirements

Subclause 8.2 of IEC 60947-1 applies with the following additions.

8.2.4 Mechanical properties of terminals

Subclause 8.2.4 of IEC 60947-1 applies with the following addition.

Where equipment is designed to be provided with different designs of terminals, the tests shall be conducted on every design.

8.2.5 Verification of the strength of actuator mechanism and position indicating device

Subclause 8.2.5 of IEC 60947-1 applies with the following additions.

8.2.5.1 Condition of equipment for tests

The test of the actuator mechanism and position indicating device shall be conducted as part of test sequence I (see 8.3.3 and Table 11).

If different types of actuators exist, either additional or integral, only one design shall be tested during sequence I. Moreover, the sample representative of the more critical case shall be tested according to 8.3.3.7.

8.2.5.2 Method of test

8.2.5.2.1 Dependent and independent manual operation

The force necessary to operate the device to the open position shall be measured at the extremity of the actuator. The measured force F shall be equal to the average value of maximum force obtained from three consecutive operations, with the device in a clean and new condition. This force F shall then be used for the establishment of the test force in Table 8.

With the equipment in the closed position, fixed and moving contacts of the pole for which the test is deemed to be the most severe shall be kept closed by appropriate means. The actuator shall be submitted to the test force as defined in Table 8 according to its type. Where the device has more than one contact system in series, each contact system shall be held in the closed position.

In the case of multiple tip contact systems, the least number of parallel contact tips shall be fixed together as necessary to hold the contact system closed in order to allow the test force to be applied without the contacts separating.

The appropriate means to keep the contact(s) closed and the number of contacts shall be specified by the manufacturer. The number of contacts and the method shall be stated in the report.

This force shall be applied without shock to the actuator in a direction to open the contacts for a period of 10 s.

The direction of the force, as shown in Figure 1, shall be maintained throughout the test.

If locking means are provided to lock the actuator in the open position it shall not be possible to lock the actuator in this position while the test force is applied.

8.2.5.2.2 Dependent power operation

With the equipment in the closed position, the fixed and moving contacts of the pole for which the test is deemed to be the most severe shall be fixed together, for example by welding. Where the device has more than one contact system in series, each contact system shall be held in the closed position.

In the case of multiple tip contact systems, the least number of parallel contact tips shall be fixed together as necessary to hold the contact system closed in order to allow the test force to be applied without the contacts separating.

The appropriate means to keep the contact(s) closed and the number of contacts shall be specified by the manufacturer. The number of contacts and the method shall be stated in the report.

The supply voltage to the power operator shall be applied at 110 % of its normal rated value to attempt to open the contact system of the equipment.

Three attempts to operate the equipment at 5 min intervals by the power operator shall be made, each for a period of 5 s, unless an associated protective device of the power operator limits the time to a shorter period.

Verification shall be made according to 8.2.5.3.2.

NOTE In Canada and the United States of America, devices meeting these requirements are not accepted as assuring isolation themselves.

8.2.5.2.3 Independent power operation

With the equipment in the closed position, the fixed and moving contacts of the pole for which the test is deemed to be the most severe shall be fixed together, for example by welding. Where the device has more than one contact system in series, each contact system shall be held in the closed position.

In the case of multiple tip contact systems, the least number of parallel contact tips shall be fixed together as necessary to hold the contact system closed in order to allow the test force to be applied without the contacts separating.

The appropriate means to keep the contact(s) closed and the number of contacts shall be specified by the manufacturer. The number of contacts and the method shall be stated in the report.

The stored energy of the power operator shall be released to attempt to open the contact system of the equipment.

Three attempts to operate the equipment by releasing the stored energy shall be made.

Verification shall be made according to 8.2.5.3.2.

NOTE In Canada and the United States of America, devices meeting these requirements are not accepted as assuring isolation themselves.

8.2.5.3 Condition of equipment during and after test

8.2.5.3.1 Dependent and independent manual operation

After the test and when the test force is no longer applied to the actuator with the actuator being left free, the indication of the open position shall not be wrongly given.

Table 8 – Actuator test force

Type of actuator	Test force	Minimum test force N	Maximum test force N
Pushbutton (see Figure 1a)	3*F*	50	150
One-finger operated (see Figure 1b)	3*F*	50	150
Two-finger operated (see Figure 1c)	3*F*	100	200
One-hand operated (see Figure 1d and 1e)	3*F*	150	400
Two-hand operated (see Figure 1f)	3*F*	200	600
Two-hand operated (see Figure 1g)	3*F*	200	600
F is the normal operating force in new condition. The test force shall be 3 *F* with the stated minimum and maximum values and be applied as shown in Figure 1.			

8.2.5.3.2 Dependent and independent power operation

During and after the test, the open position shall not be indicated by any of the means provided and the equipment shall not show any damage such as to impair its normal operation.

When the equipment is provided with means for padlocking in the open position, it shall not be possible to lock the equipment during the test.

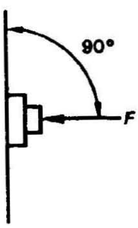


Figure 1a

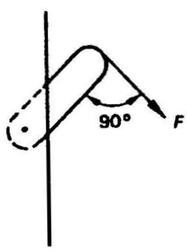


Figure 1b

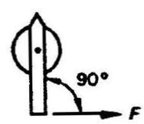


Figure 1c

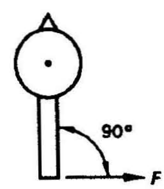


Figure 1d

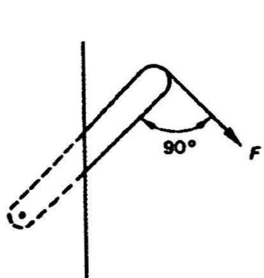


Figure 1e

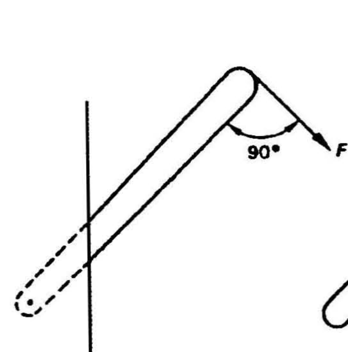


Figure 1f

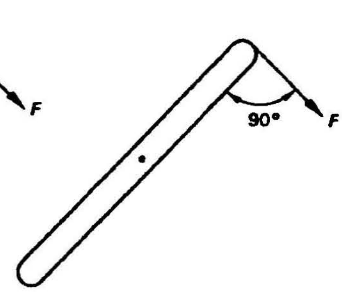


Figure 1g

Figure 1 – Actuator applied force *F*

Table 9 – List of type tests applicable to a given equipment

Test	Switch	Fuse-switch	Switch-fuse	Dis-connector	Discon-nector-fuse	Fuse dis-connector	Switch dis-connector	Switch dis-connector-fuse	Fuse-switch dis-connector
Temperature-rise [a]	o	o	o	o	o	o	o	o	o
Temperature-rise verification	o	o	o	o	o	o	o	o	o
Dielectric properties	o	o	o	o	o	o	o	o	o
Dielectric verification	o	o	o	o	o	o	o	o	o
Leakage current	–	–	–	o	o	o	o	o	o
Rated making and breaking capacities (overload)	o	o	o	–	–	–	o	o	o
Operational performance	o	o	o	o	o	o	o	o	o
Rated short-time with-stand current	o	–	–	o	–	–	o	–	–
Rated short-circuit making capacity	o	–	–	–	–	–	o	–	–
Rated conditional short-circuit current	o	o	o	o	o	o	o	o	o
Strength of actuator mechanism	–	–	–	o	o	o	o	o	o
Overload test	–	o	o	–	o	o	–	o	o

[a] Applies to 8.3.2.1.3 only.

o = test

– = no test required

8.3 Type tests for performance

Performance type tests to which equipment may be submitted according to its kind are listed in Table 9.

8.3.1 Test sequences

Type tests are grouped together in a number of sequences as shown in Table 10.

For each sequence, tests shall be made in the order listed in accordance with the requirements of the appropriate subclause, apart from the temperature-rise test (simplified testing only) and dielectric properties test of test sequence I, which may be conducted on a separate sample.

Table 10 – Overall scheme of test sequences

Sequence	Tests
General performance characteristics (see 8.3.3 and Table 11)	Temperature-rise [f, g] Dielectric properties [f] Making and breaking capacities [e] Dielectric verification [a] Leakage current [b] Temperature-rise verification Strength of actuator mechanism
Operational performance capability (see 8.3.4 and Table 13)	Operational performance Dielectric verification Leakage current [b] Temperature-rise verification
Short-circuit performance capability [c] (see 8.3.5 and Table 14)	Short-time withstand current Short-circuit making capacity [e] Dielectric verification Leakage current [b] Temperature-rise verification
Conditional short-circuit current [c] (see 8.3.6 and Table 15)	Fuse protected short-circuit withstand Fuse protected short-circuit making Dielectric verification Leakage current [b] Temperature-rise verification
Overload performance capability [d] (see 8.3.7 and Table 16)	Overload test Dielectric verification Leakage current [b] Temperature-rise verification

[a] Not required for disconnectors (AC-20 or DC-20). See 4.3.5.2 and 4.3.5.3.

[b] Only required for equipment suitable for isolation of rated voltage greater than 50 V.

[c] Either test sequence III or test sequence IV to be made according to the ratings stated by the manufacturer.

[d] Not required for switches, disconnectors and switch-disconnectors.

[e] Not applicable to AC-20 or DC-20 equipment.

[f] May be conducted outside of the sequence, see 8.3.1.

[g] Applies to 8.3.2.1.3 only.

8.3.2 General test conditions

8.3.2.1 General requirements

Subclause 8.3.2.1 of IEC 60947-1 applies to all type tests as applicable. The equipment at the start of any test sequence shall be in new and clean condition.

The force applied for any opening operation shall not be greater than the test force determined in 8.2.5.2 and shall be applied in the same manner without shock.

Where doubt exists as to the correct opening operation, no more than three attempts to operate the equipment to the open position are allowed.

In order to reduce multiple testing for the same fundamental design of equipment, the following test requirements may be used.

8.3.2.1.1 Simplified test for equipment having the same fundamental design

When submitting simultaneously a range of switches, disconnectors, switch-disconnectors or fuse combination units of the same fundamental design, the following variations are permitted provided the equipment complies in all other respects.

8.3.2.1.2 Requirements for equipment having the same fundamental design

Switches, disconnectors, switch-disconnectors or fuse combination units shall be evaluated with respect to the following criteria during the determination of acceptance as the same fundamental design:

a) the material, finish and dimensions of the current-carrying parts are identical, except for variation in design of terminals and means of fuse attachment;

b) the contact size, material, configuration and method of attachment are identical;

c) the operating mechanism is of the same fundamental design, materials and physical characteristics are identical;

d) the closing and opening speeds of contacts are substantially the same;

e) moulding and insulating materials are identical;

f) method, materials and construction of any arc extinction device are identical.

The following variations are also permitted, provided the simplified test procedure given in 8.3.2.1.3 is used:

g) utilization category and operational voltage;

h) application for 50 Hz or 60 Hz;

i) three or four pole equipment (switched or non-switched neutral), provided the requirements of 7.1.8 are applicable;

j) design of terminal provided that clearances and creepage distance are not reduced (see 7.1.3, 8.2.4 and 8.3.3.2 of this standard and 8.3.3.1 of IEC 60947-1);

k) different types of actuators, either additional or integral, provided the requirements for strength of actuator are verified (see 8.2.5) on each type of actuator, one of which during test sequence I;

l) fuse-base contacts of switch-fuses, disconnector-fuses and switch-disconnector-fuse with different types of fuse-links (fuse-link removed only under no-load conditions).

8.3.2.1.3 Simplified test procedure

The following simplified test procedure shall be used.

a) If equipment having the same fundamental design is marked claiming more than one utilization category and/or more than one operational voltage, the number of test samples may be reduced, providing the tests are conducted under the most severe conditions.

   For short-circuit, making and breaking, and operational performance tests, the conditions are deemed more severe if the following conditions are simultaneously fulfilled:

   - operational rated voltage equal or higher;
   - test current equal or higher;
   - power factor equal or lower;
   - number of operations equal or higher.

b) Tests performed at 50 Hz are deemed to cover 60 Hz applications and vice versa with the following exceptions:

   - temperature-rise test according to 8.3.3.1 for devices having a current greater than 800 A;

   NOTE By agreement between manufacturer and user, tests at 50 Hz may be accepted for operation at 60 Hz and vice versa for currents greater than 800 A.

- temperature-rise and operational performance of relays and releases (see 7.2.2 and 7.2.2.6 of IEC 60947-1). Temperature-rise tests of coils shall be performed for each frequency, but only one included in the relevant test sequence, and if separate supplying of coils and other circuits is possible, it is accepted that other circuits remain supplied at 50 Hz.

c) Tests performed on three pole devices are deemed to cover also four pole devices with a non-switched neutral pole, provided a single-phase test on the neutral pole is performed according to 8.3.3.3.4 of IEC 60947-1.

   Tests performed on four switched pole devices are deemed to cover also three switched pole devices provided that all poles are identical and the closing and opening speeds of contacts are substantially the same (only the requirements of 7.1.8 are applicable concerning closing and opening of the neutral pole). However, the four switched pole devices shall always be connected in a three-phase arrangement (see Figure 11 of IEC 60947-1).

d) Tests performed with different types of fuse-base contacts.

   Where switch-fuse, disconnector-fuse or switch-disconnector-fuse are designed to be provided with different types of fuse-base contacts, temperature-rise tests according to 8.3.3.1 shall be conducted on each type at the corresponding highest fuse rated current.

   The type having the maximum temperature-rise among those of the maximum test current shall be used for tests to sequences I, II and V.

   Sequence IV shall be conducted on each type of fuse-base contacts whose fuse connecting means are other than bolted connection, at the highest rated conditional short circuit corresponding current, and, if different, with the type of fuse having the maximum let-through energy at the highest test voltage.

e) Tests performed with different terminal designs.

   Where equipment is designed to be provided with different designs of terminal, the requirements and tests according to 8.3.3.1 and 8.2.4 of IEC 60947-1 shall be conducted on each design.

   Where equipment has terminals to be used on plug-on busbars, tests according to 8.3.3.1, 8.3.5.1 or 8.3.6.2.1a), as applicable, shall be performed. Verification of the plugging operation shall be made. The number of operating cycles shall be 50, the cycle being from the connected position to the disconnected position and back to the connected position.

The test is considered to be satisfactory if the operating conditions of the apparatus have not been impaired.

8.3.2.2 Test quantities

Subclause 8.3.2.2 of IEC 60947-1 applies.

8.3.2.3 Evaluation of test results

The behaviour of the equipment during the tests and its condition after the tests are specified in the appropriate test clause.

8.3.2.4 Test report

Subclause 8.3.2.4 of IEC 60947-1 applies.

8.3.3 Test sequence I: General performance characteristics

This test sequence applies to the types of equipment listed in Table 11 and comprises the tests according to the table.

8.3.3.1 Temperature-rise

Subclause 8.3.3.3 of IEC 60947-1 applies with the following additions:

The test shall be made at the conventional enclosed thermal current I_{the} (see 4.3.2.2 of IEC 60947-1).

Fuse-combination units shall be fitted with fuse-links having a rated current equal to the conventional thermal current of the combination unit.

The fuse-link shall have a power loss not exceeding the maximum value specified by the equipment manufacturer.

NOTE The test may be made with a "dummy" fuse-link of essentially similar design to the standardized fuse-link and having the specified power loss.

Details of the fuse-links used for the test, i.e. the manufacturer's name and reference, the rated current, the power loss of the fuse-link, and the breaking capacity, shall be given in the test report. The type test with the specified fuse-links shall be deemed to cover the use of any other fuse-link having a power loss, at the conventional thermal current of the combination unit, not exceeding the power loss of the fuse-link used for the test.

Table 11 – Test sequence I: General performance characteristics

Test	Sub-clause No.	Sample [c]	Type of equipment and order of tests					
			Switch	Fuse-switch and switch-fuse	Discon-nector	Discon-nector-fuse and fuse-discon-nector	Switch-discon-nector	Switch-discon-nector-fuse and fuse-switch-discon-nector
Temperature-rise [d, e]	8.3.3.1	A,B,C,F	1	1	1	1	1	1
Dielectric properties [d]	8.3.3.2	A,C,F	2	2	2	2	2	2
Making and breaking capacities	8.3.3.3	A,D	3	3	[a]	[a]	3	3
Dielectric verification	8.3.3.4	A,D	4	4	[a]	[a]	4	4
Leakage current [b]	8.3.3.5	A,D	-	-	3	3	5	5
Temperature-rise verification	8.3.3.6	A,D	5	5	4	4	6	6
Strength of actuator mechanism	8.3.3.7	A,E	-	-	5	5	7	7

[a] This test is not required for disconnectors (AC-20 or DC-20). See 4.3.5.2 and 4.3.5.3.

[b] Test required only for U_e greater than 50 V.

[c] Only tests marked by the same letter shall be applied in sequence to a given sample: "A" is a sample from the most common design, chosen from the highest rated current I_e, and if applicable, having the maximum temperature-rise according to 8.3.2.1.3, item d).

Other samples if applicable:

"B" is a different sample for 60 Hz test, if applicable, according to 8.3.2.1.3, item b);

"C" are samples of each other terminal design tested at correspondent maximum rated current;

"D" are samples to verify as many combinations of U_e, I_e, AC or DC voltage ratings, to be tested (see 8.3.2.1.3);

"E" is the extra sample as specified in 8.2.5.1 and can be one of sample B, C or D;

"F" are samples of every type of fuse-carrier of fuse-combination unit according to 8.3.2.1.3, item d).

[d] May be conducted outside of the sequence, see 8.3.1.

[e] Applies only to 8.3.2.1.3.

8.3.3.2 Test of dielectric properties

Subclause 8.3.3.4.1 of IEC 60947-1 applies with the following addition.

When, in agreement with the manufacturer, devices are disconnected for the test according to 8.3.3.4.1 3) c) of IEC 60947-1, the test report shall state these devices.

For equipment suitable for isolation (see 3.3) having an operational voltage U_e greater than 50 V, the leakage current shall be measured through each pole with the contacts in the open position, at a test voltage of 1,1 U_e and shall not exceed 0,5 mA.

8.3.3.3 Making and breaking capacities

8.3.3.3.1 Test values and conditions

Subclause 8.3.3.5 of IEC 60947-1 applies regarding equipment provided with a neutral pole.

The test values are stated in 7.2.4.1, Table 3, according to the utilization category.

The stated number of make-break operating cycles shall be made with a time interval between close-open cycles of 30 s ± 10 s except that for equipment of conventional thermal current of 400 A or more, the time interval may be increased by agreement between manufacturer and user and the interval shall be stated in the test report.

During each make-break operating cycle, equipment need only stay in the closed position for a period long enough to allow the switching operation to be completed and to enable the current value to be established and the moving parts of the equipment to come to rest. After each operating cycle, the recovery voltage shall be maintained for at least 0,05 s.

For convenience of testing, equipment of utilization categories AC-23A and AC-23B, make-break operating cycles may be replaced, with the agreement of the manufacturer, by the stated number of 10 I_e make cycles followed by the same number of 8 I_e break cycles.

For a.c. the power-factor of the test circuit shall be determined in accordance with 8.3.4.1.3 of IEC 60947-1. The values shall be in accordance with Table 3.

For d.c. the time-constant of the test circuit shall be determined in accordance with 8.3.4.1.4 of IEC 60947-1. The values shall be in accordance with Table 3.

The test voltage and the load shall be applied to the appropriate terminals of the equipment. For equipment in which a moving contact remains connected to one of the terminals when the equipment is in the open position, this test shall be repeated with the supply and load connections interchanged, unless the terminals are specifically and clearly marked for load and supply.

In the case of tests carried out on fuse-combination units, fuse-links may be replaced by suitable copper links of dimensions and mass electrically equivalent to those of the fuse-links recommended by the manufacturer.

8.3.3.3.2 Test circuit

Subclause 8.3.3.5.2 of IEC 60947-1 applies.

8.3.3.3.3 Transient recovery voltage

Subclause 8.3.3.5.3 of IEC 60947-1 applies only to utilization categories AC-22 and AC-23. For tests for utilization categories DC-22 and DC-23 the test circuit load may be replaced by a motor producing the specified current and time constant value if agreed between manufacturer and user.

8.3.3.3.4 Vacant

8.3.3.3.5 Behaviour of equipment during making and breaking capacity tests

The equipment shall perform during the above tests in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall be no permanent arcing or flash-over between poles or between poles and frame and no melting of the fuse in the detection circuit.

The equipment shall remain mechanically operable. Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

8.3.3.3.6 Condition of equipment after the making and breaking capacity tests

It shall be demonstrated immediately after the test that the equipment will close and open satisfactorily during a no-load close/open operation.

The force required for opening shall not be greater than the test force of 8.2.5.2 and Table 8.

A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the equipment to be able to carry its rated operational current.

After the test and without maintenance the equipment shall comply with the requirements of 8.3.3.4.

The contacts shall be in a suitable condition to carry the rated operational current without maintenance and shall comply with the temperature-rise verification of 8.3.3.6.

If the equipment is suitable for isolation, it shall comply with 8.3.3.5 and 8.3.3.7.

8.3.3.4 Dielectric verification

After the test according to 8.3.3.3, a test shall be made according to 8.3.3.4.1 4) of IEC 60947-1.

8.3.3.5 Leakage current

This test is made only on equipment suitable for isolation of rated operational voltage U_e greater than 50 V. The leakage current shall be checked across each contact gap and from each terminal to the frame.

The value of leakage current, with a test voltage equal to 1,1 times the rated operational voltage of equipment shall not exceed

- 0,5 mA per pole for equipment of utilization category AC-20A, AC-20B, DC-20A or DC-20B;
- 2 mA per pole for equipment of all other utilization categories.

8.3.3.6 Temperature-rise verification

After the tests according to 8.3.3.3, the temperature-rise of the terminals and accessible parts shall be checked according to 8.3.3.1 except that where a utilization category is assigned the tests are made at the rated operational current I_e of the equipment tested.

The terminals and accessible parts shall not exceed the limiting values stated in Table 12.

Table 12 – Temperature-rise limits for terminals and accessible parts

Description of part [a]	Temperature-rise limits K
Terminals for external connections	80
Manual operating means: – metallic – non-metallic	 25 35
Parts intended to be touched but not hand-held: – metallic – non-metallic	 40 50
Parts which need not be touched for normal operation: – metallic – non-metallic	 50 60
[a] No value is specified for parts other than those listed but no damage shall be caused to adjacent parts of insulating materials.	

8.3.3.7 Strength of actuator mechanism

Subclause 8.2.5 applies to equipment suitable for isolation.

8.3.4 Test sequence II: Operational performance capability

This test sequence applies to the types of equipment listed in Table 13 and comprises the tests according to this table.

They are made to verify compliance with 7.2.4.2.

Table 13 – Test sequence II: Operational performance capability

Test	Sub-clause No.	Sample [c]	Type of equipment and order of tests					
			Switch	Fuse-switch and switch-fuse	Discon-nector	Discon-nector-fuse and fuse-discon-nector	Switch-discon-nector	Switch-discon-nector-fuse and fuse-switch-discon-nector
Operational performance	8.3.4.1	A, B	1	1	[a]	[a]	1	1
Dielectric verification	8.3.4.2	A, B	2	2	1	1	2	2
Leakage current [b]	8.3.4.3	A, B	–	–	2	2	3	3
Temperature-rise verification	8.3.4.4	A, B	3	3	3	3	4	4

[a] Load-breaking operations are not required for categories AC-20 and DC-20. See also 4.3.5.2 and 4.3.5.3 as applicable.

[b] Test required only for U_e greater than 50 V.

[c] "A" is a sample from the most common design, chosen from the highest rated current I_e, and if applicable, having the maximum temperature-rise according to 8.3.2.1.3d).
"B", if applicable, are samples to verify as many combinations of U_e, I_e, AC or DC voltage ratings, to be tested.

8.3.4.1 Operational performance test

8.3.4.1.1 Test values and conditions

The test values are stated in Tables 4 and 5, according to the utilization category.

The time interval between Table 4 operating cycles with current and without current and the sequential order of the tests shall be stated in the test report.

During each make-break operating cycle, the equipment need only stay in the closed position for a period long enough to allow the switching operation to be completed and to enable the current value to be established and the moving parts of the equipment to come to rest. After each operating cycle, the recovery voltage shall be maintained for at least 0,05 s.

For a.c. the power-factor of the test circuit shall be determined in accordance with 8.3.4.1.3 of IEC 60947-1. The values shall be in accordance with Table 5.

For d.c. the time-constant of the test circuit shall be determined in accordance with 8.3.4.1.4 of IEC 60947-1. The values shall be in accordance with Table 5.

8.3.4.1.2 Test circuit

Subclause 8.3.3.5.2 of IEC 60947-1 applies.

8.3.4.1.3 Transient recovery voltage

It is not necessary to adjust the transient recovery voltage.

8.3.4.1.4 Switching overvoltages

Under consideration.

8.3.4.1.5 Behaviour of the equipment during the operational performance test

The equipment shall perform during the above tests in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall be no permanent arcing or flash-over between poles or between poles and frame and no melting of the fuse in the detection circuit.

The equipment shall remain mechanically operable. Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

Some wear on the mechanism and contacts is allowed provided that the equipment functions correctly.

8.3.4.1.6 Condition of the equipment after the operational performance test

It shall be demonstrated immediately after the test that the equipment will close and open satisfactorily during a no-load close/open operation.

The force required for opening shall not be greater than the test force of 8.2.5.2 and Table 8.

A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the equipment to be able to carry its rated operational current.

After the tests and without maintenance the equipment shall comply with the requirements of 8.3.4.2.

The contacts shall be in a suitable condition to carry the rated operational current without maintenance and shall comply with the temperature-rise verification of 8.3.4.4.

If the equipment is suitable for isolation, it shall comply with 8.3.4.3.

8.3.4.2 Dielectric verification

Subclause 8.3.3.4 applies.

8.3.4.3 Leakage current

Subclause 8.3.3.5 applies.

8.3.4.4 Temperature-rise verification

Subclause 8.3.3.6 applies.

8.3.5 Test sequence III: Short-circuit performance capability

This test sequence applies to the types of equipment listed in Table 14 and comprises the tests according to this table.

This test sequence is not mandatory if a value of rated short-circuit making capacity is not stated by the manufacturer (see 8.3.5.2.1) and test sequence IV (see 8.3.6) is carried out.

The tests are made to verify compliance with 7.2.5.

Table 14 – Test sequence III: Short-circuit performance capability

Test	Sub-clause No.	Sample [d]	Type of equipment and order of tests					
			Switch	Fuse-switch and switch-fuse	Discon-nector	Discon-nector-fuse and fuse-discon-nector	Switch-discon-nector	Switch-discon-nector-fuse and fuse-switch-discon-nector
Short-time withstand current	8.3.5.1	A	1	Not applicable	1	Not applicable	1	Not applicable
Short-circuit making capacity [a] [b]	8.3.5.2	A, B	2		-		2	
Dielectric verification	8.3.5.3	A, B	3		2		3	
Leakage current [c]	8.3.5.4	A, B	-		3		4	
Temperature-rise verification	8.3.5.5	A, B	4		4		5	

[a] Test sequence III is not mandatory if test sequence IV is carried out.

[b] Switches and switch-disconnectors not having a rated short-circuit making capacity (see 2.1) shall meet the requirements of test sequence IV (see Table 15).

[c] Test required only for U_e greater than 50 V.

[d] "A" is a sample from the most common design, chosen from the highest I_{cw} current.
"B", if applicable, are samples to verify as many combinations of U_e, I_{cw} or I_{cm}, AC or DC voltage ratings, to be tested.

8.3.5.1 Short-time withstand current test

8.3.5.1.1 Test values and conditions

The test conditions of 8.3.4.3 of IEC 60947-1 apply.

The test current shall be the rated short-time withstand current stated according to 4.3.6.1.

8.3.5.1.2 Test circuit

Subclause 8.3.4.1.2 of IEC 60947-1 applies.

For a.c., the power-factor of the test circuit shall be in accordance with 8.3.4.1.3 of IEC 60947-1.

For d.c., the time-constant of the test circuit shall be in accordance with 8.3.4.1.4 of IEC 60947-1.

8.3.5.1.3 Test circuit calibration

The calibration of the test circuit is carried out by placing temporary connections *B* of negligible impedance as close as reasonably possible to the terminals provided for connecting the equipment under test.

For a.c., resistors R_1 and reactors X are adjusted so as to obtain, at the applied voltage, a current equal to the rated short-time withstand current as well as the power-factor as indicated in 8.3.4.1.3 of IEC 60947-1.

For d.c., resistors R_1 and reactors X are adjusted so as to obtain, at the applied voltage, a current the maximum value of which is equal to the rated short-time withstand current as well as the time-constant as indicated in 8.3.4.1.4 of IEC 60947-1.

8.3.5.1.4 Test procedure

The temporary connections *B* are replaced by the equipment under test and the test current is applied for the specified time with the equipment in the closed position.

8.3.5.1.5 Behaviour of the equipment during the test

The equipment shall perform during the test in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall be no permanent arcing or flash-over between poles or between poles and frame and no melting of the fuse in the detection circuit.

The equipment shall remain mechanically operable. Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

8.3.5.1.6 Conditions of the equipment after the test

It shall be demonstrated immediately after the test that the equipment will close and open satisfactorily during a no-load close/open operation.

The force required for opening shall not be greater than the test force of 8.2.5.2 and Table 8.

A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the equipment to be able to carry its rated operational current.

After the test and without maintenance if the equipment is a switch or a switch-disconnector, it shall be subjected to the short-circuit making capacity test, 8.3.5.2, as listed in Table 14.

If the equipment is suitable for isolation, it shall comply without maintenance with the dielectric verification of 8.3.5.3.

The contacts of a disconnector shall be in a suitable condition without maintenance to carry the rated operational current and shall comply with the temperature-rise of 8.3.5.5.

8.3.5.2 Short-circuit making capacity test

8.3.5.2.1 Test values and conditions

The test shall be made on the same equipment as for the test of 8.3.5.1 without any maintenance.

The test current shall be that assigned by the manufacturer as stated in 4.3.6.2.

8.3.5.2.2 Test circuit

Subclause 8.3.5.1.2 applies.

8.3.5.2.3 Test circuit calibration

The calibration of the test circuit is carried out by placing temporary connections *B* of negligible impedance as close as reasonably possible to the terminals provided for connecting the equipment under test.

Depending upon whether the equipment is rated a.c. or d.c. the calibration is made as follows.

a) For a.c.:

   The tests shall be made at the rated frequency of the equipment.

   The prospective current shall be applied for at least 0,05 s and its value is the r.m.s. value determined from the calibration record. This value shall be equal to or higher than the specified value in at least one pole.

   The average value of all phases shall comply with the tolerances in 8.3.2.2 of IEC 60947-1.

   The highest peak value of the prospective current during its first cycle shall be not less than *n* times the rated short-circuit current, the value of *n* being as stated in the third column of Table 16, of IEC 60947-1.

b) For d.c.:

   The current shall be applied for the specified time and its mean value, determined from the record, shall be at least equal to the specified value.

   If the testing station is unable to make these tests on d.c., they may, if agreed between manufacturer and user, be made on a.c., provided suitable precautions are taken, for instance, the peak value of current shall not exceed the permissible current.

For an equipment having the same rated current for a.c. and d.c. the a.c. test shall be taken as valid for the d.c. rating.

8.3.5.2.4 Test procedure

The temporary connections *B* are replaced by the equipment under test and the equipment shall be closed twice with an interval of approximately 3 min between these operations on a prospective peak current not less than the rated short-circuit making capacity of the equipment. The current shall be maintained for at least 0,05 s.

The closing mechanism shall be operated so as to simulate service conditions as closely as possible.

8.3.5.2.5 Behaviour of the equipment during the test

The equipment shall perform during the above tests in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall not be permanent arcing or flash-over between poles or between poles and frame and no melting of the fuse in the detection circuit.

The equipment shall remain mechanically operable. Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

8.3.5.2.6 Condition of the equipment after the test

It shall be demonstrated immediately after the test that the equipment will open and close satisfactorily during a no-load open/close operation.

The force required for opening shall not be greater than the test force of 8.2.5.2 and Table 8.

A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the equipment to be able to carry its rated operational current.

After the test and without maintenance the equipment shall comply with the dielectric verification of 8.3.5.3.

The contacts shall be in a suitable condition without maintenance to carry the highest rated operational current and shall comply with the temperature-rise verification of 8.3.5.5.

8.3.5.3 Dielectric verification

Subclause 8.3.3.4 applies.

8.3.5.4 Leakage current

Subclause 8.3.3.5 applies, except that the maximum value of leakage current shall not exceed 2 mA per pole for all utilization categories.

8.3.5.5 Temperature-rise verification

Subclause 8.3.3.6 applies.

8.3.6 Test sequence IV: Conditional short-circuit current

This test sequence applies to the types of equipment listed in Table 15 and comprises the tests according to the table.

This test sequence is not mandatory if a value of rated conditional short-circuit current is not stated by the manufacturer and test sequence III (see 8.3.5) is carried out.

For switches, disconnectors and switch-disconnectors the short-circuit protective device of the equipment may be a circuit-breaker or a fuse and shall be arranged on the load side of the equipment under test.

The type of circuit breaker or fuse shall be that stated by the manufacturer as suitable for the equipment.

Details of the protective device used for the test i.e. manufacturer's name, type designation, rated voltage, current and short-circuit breaking capacity shall be given in the test report.

The type test with the specified protective device shall be deemed to cover the use of any other protective device having a Joule integral (I^2t) and cut-off current at the rated voltage, prospective current and power-factor not exceeding the specified values for the type of protective device used for the test.

The tests are made to verify compliance with 7.2.5.

8.3.6.1 Circuit-breaker protected short-circuit withstand

Under consideration.

8.3.6.2 Fuse protected short-circuit withstand

8.3.6.2.1 Test values and conditions

The fuse-links shall be of the rated maximum current and rated breaking capacity deemed suitable by the manufacturer for use with the equipment.

The equipment manufacturer shall supply the fuse-links (see IEC 60269 series) to be used for the test. Details of the fuse-links used shall be recorded in the test report.

The test voltage to be used shall be equal to 1,05 U_e, where U_e corresponds to the operational voltage of the device under test.

The test shall be made as follows.

a) Withstand test

A prospective current corresponding to the rated conditional short-circuit current stated by the manufacturer shall be applied with the equipment in the closed position.

b) Making test

After the withstand test of item a), all equipment according to Table 15 shall be fitted with new fuse-links and closed on to the rated conditional short-circuit current.

Table 15 – Test sequence IV: Conditional short-circuit current

Test	Sub-clause No.	Sample c)	Type of equipment and order of tests					
			Switch a)	Fuse-switch and switch-fuse	Discon-nector a)	Discon-nector-fuse and fuse-discon-nector	Switch-discon-nector a)	Switch-discon-nector-fuse and fuse-switch-discon-nector
Fuse protected short-circuit withstand	8.3.6.2.1a)	A, B	1	1	1	1	1	1
Fuse protected short-circuit making	8.3.6.2.1b)	A, B	2	2	–	–	2	2
Dielectric verification	8.3.6.3	A, B	3	3	2	2	3	3
Leakage current b	8.3.6.4	A, B	–	–	3	3	4	4
Temperature-rise verification	8.3.6.5	A, B	4	4	4	4	5	5

a Test sequence IV is not mandatory if test sequence III is carried out (see Table 14).

b Test required only for U_e greater than 50 V.

c "A" is a sample from the most common design, chosen from the highest rated conditional short-circuit current, or if applicable, "A" are samples of each type according to 8.3.2.1.3d).
"B" if applicable, are samples to verify as many combinations of U_e, I_q, AC or DC voltage ratings, to be tested.

8.3.6.2.2 Test circuit

Subclause 8.3.5.1.2 applies.

8.3.6.2.3 Test circuit calibration

Subclause 8.3.5.2.3 applies.

8.3.6.2.4 Test procedure

For fuse-switches, fuse disconnectors and fuse-switch disconnectors, the closing mechanism shall be operated according to 7.2.1.1.

The temporary connections are replaced by the equipment under test and the test current applied according to 8.3.6.2.1.

The recovery voltage shall be maintained for at least 0,05 s after interruption of the test current by the fuse.

8.3.6.2.5 Behaviour of the equipment during the test

Subclause 8.3.5.2.5 applies.

8.3.6.2.6 Condition of the equipment after the test

Subclause 8.3.5.2.6 applies.

8.3.6.3 Dielectric verification

Subclause 8.3.3.4 applies.

8.3.6.4 Leakage current

Subclause 8.3.5.4 applies.

8.3.6.5 Temperature-rise verification

Subclause 8.3.3.6 applies.

8.3.7 Test sequence V: Overload performance capability

This test sequence applies to the types of equipment listed in Table 16 and comprises the tests according to the table.

8.3.7.1 Overload test

The equipment shall first be temperature conditioned at room temperature. The test current is 1,6 I_{the} or 1,6 I_{th} (see 4.3.2.2 of IEC 60947-1) for a period of 1 h, or until one or more of the fuses blow. If the time is less than 1 h, the time shall be recorded in the test report.

The equipment manufacturer shall supply the fuse-links (see IEC 60269 series) to be used for the test. Details of the fuse-links used shall be recorded in the test report.

Subclause 8.3.3.1 applies with the exception that no temperatures have to be measured.

Within 3 min to 5 min after the fuse(s) has (have) operated or the period of 1 h is over, the equipment shall be operated once, i.e. opened and closed. The equipment shall not have undergone any impairment hindering such operation. The force to open the equipment shall not be greater than the actuator test force of 8.2.5.2 and Table 8.

The time duration of the overload test shall be measured and given in the test report.

8.3.7.2 Dielectric verification

Subclause 8.3.3.4 applies.

8.3.7.3 Leakage current

Subclause 8.3.3.5 applies.

8.3.7.4 Temperature-rise verification

Subclause 8.3.3.6 applies with the addition of the following:

Fuse-links aged during the overload test according to 8.3.7.1 shall be replaced by new fuse-links of the same type and rating.

Table 16 – Test sequence V: Overload performance capability

Test	Sub-clause No.	Sample [b]	Type of equipment and order of tests		
			Fuse-switch and switch-fuse	Disconnector-fuse and fuse-disconnector	Switch-disconnector-fuse and fuse-switch-disconnector
Overload test	8.3.7.1	A	1	1	1
Dielectric verification	8.3.7.2	A	2	2	2
Leakage current [a]	8.3.7.3	A	–	3	3
Temperature-rise verification [c]	8.3.7.4	A	3	4	4

[a] Test required only for U_e greater than 50 V.

[b] "A" is a sample from the most common design, chosen from the highest rated current I_e, and if applicable, having the maximum temperature-rise according to 8.3.2.1.3d).

[c] By agreement with the manufacturer, the test sequence may be changed so that the temperature-rise verification test follows directly after the overload test, followed by dielectric verification and the leakage current tests, as applicable.

8.4 Electromagnetic compatibility tests

Subclause 8.4 of IEC 60947-1 applies with the following addition.

During tests, the following performance criterion applies:

– unintentional separation or closing of contacts shall not occur.

8.4.1 Immunity

8.4.1.1 Equipment not incorporating electronic circuits

No tests are necessary (see 7.3.2.1).

8.4.1.2 Equipment incorporating electronic circuits

The requirements of 7.3.2.2 apply. To verify compliance with these requirements, the tests contained in Table 6 shall be conducted.

8.4.2 Emission

8.4.2.1 Equipment not incorporating electronic circuits

No tests are necessary (see 7.3.3.1).

8.4.2.2 Equipment incorporating electronic circuits

The requirements of 7.3.3.2 apply. The limits contained in Table 7 shall be verified by tests.

Measurements shall be made in the operating mode, including grounding conditions, producing the highest emission in the frequency band being investigated which is consistent with normal service conditions (see clause 6).

Each measurement shall be performed in defined and reproducible conditions.

8.5 Special tests

Resistance to mechanical and/or electrical wear is demonstrated by the operational performance test detailed in 8.3.4.1.

Where abnormal service conditions are expected (see also note to 7.2.4.3 of IEC 60947-1), the following tests may be necessary:

8.5.1 Mechanical durability

The mechanical durability test (see 7.2.4.3 and 8.1.5), where required, is made in accordance with the appropriate requirements of 8.3.4.1, except that for equipment suitable for isolation, the maximum value of leakage current shall not exceed 6 mA per pole for all utilization categories.

The total number of operating cycles shall be as declared by the manufacturer.

8.5.2 Electrical durability

The electrical durability test (see 7.2.4.4 and 8.1.5), where required, is made in accordance with the appropriate requirements of 8.3.4.1, except that for equipment suitable for isolation, the maximum value of leakage current shall not exceed 6 mA per pole for utilization categories AC-21, AC-22, AC-23, DC-21, DC-22 and DC-23.

Equipment of utilization categories AC-20A, AC-20B, DC-20A and DC-20B is not submitted to this test.

The total number of operating cycles shall be as declared by the manufacturer.

Annex A
(normative)

Equipment for direct switching of a single motor

Switches, switch-disconnectors and fuse-combination units normally intended for direct switching of individual motors shall comply with the additional requirements of this annex. These requirements are essentially the same as the appropriate subclauses of IEC 60947-4-1 and equipment complying with this annex may state on the nameplate the appropriate utilization category according to Table A.1.

A.1 Rated duty

Additional rated duties considered as standard are as follows.

A.1.1 Intermittent periodic duty or intermittent duty

Subclause 4.3.4.3 of IEC 60947-1 applies with the following additions.

A.1.1.1 Classes of intermittent duty

According to the number of operating cycles which they shall be capable of carrying out per hour, equipment is divided into the following classes:

- Class 1: up to 1 operating cycle per hour;
- Class 3: up to 3 operating cycles per hour;
- Class 12: up to 12 operating cycles per hour;
- Class 30: up to 30 operating cycles per hour;
- Class 120: up to 120 operating cycles per hour.

A.1.2 Temporary duty

Subclause 4.3.4.4 of IEC 60947-1 applies.

A.2 Making and breaking capacities

An equipment is defined by its making and breaking capacities, in accordance with utilization categories as specified in Table A.2 (see A.3).

A.3 Utilization category

The utilization categories as given in A.1 are considered standard in this annex. Any other type of utilization category shall be based on agreement between manufacturer and user but information given in the manufacturer's catalogue or tender may take the place of such an agreement.

Each utilization category is characterized by the values of the currents and voltages, expressed as multiples of the rated operational current and of the rated operational voltage, and by the power-factors or time-constants as shown in Table A.2 and other test conditions used in the definitions of the rated making and breaking capacities.

For equipment defined by their utilization category, it is therefore unnecessary to specify separately the rated making and breaking capacities as these values depend directly on the utilization category as shown in Table A.2.

The utilization categories of Table A.2 correspond in principle to the applications listed in Table A.1.

Table A.1 – Utilization categories

Utilization category		Typical applications
AC	AC-2	Slip-ring motors: starting, plugging [a], switching off
	AC-3	Squirrel-cage motors: starting, switching off of motors during running
	AC 4	Squirrel-cage motors: starting, plugging [a], inching [b]
DC	DC-3	Shunt motors: starting, plugging [a], inching [b], dynamic breaking of d.c. motors
	DC-5	Series-motors: starting, plugging [a] inching[b], dynamic breaking of d.c. motors

NOTE The switching of rotor circuits, capacitors or tungsten filament lamps shall be subject to special agreement between manufacturer and user.

[a] Plugging is understood to mean stopping or reversing the motor rapidly by reversing motor primary connections while the motor is running.

[b] Inching (jogging) is understood to mean energizing a motor once or repeatedly for short periods to obtain small movements of the driven mechanism.

Table A.2 – Rated making and breaking capacity conditions corresponding to several utilization categories

Utilization category	Make and break conditions					
	I_c/I_e	U_r/U_e	cos ϕ	On-time s [b]	Off-time s	Number of operating cycles
AC-2	4,0	1,05	0,65	0,05	[c]	50
AC-3 [e]	8,0	1,05	[a]	0,05	[c]	50
AC-4 [e]	10,0	1,05	[a]	0,05	[c]	50
			L/R ms			
DC-3	4,0	1,05	2,5	0,05	[c]	50 [f]
DC-5	4,0	1,05	15,0	0,05	[c]	50 [f]
	Make conditions					
Utilization category	I/I_e	U/U_e	cos ϕ	On-time s [b]	Off-time s	Number of operating cycles
AC-3	10	1,05 [d]	[a]	0,05	10	50
AC-4	12	1,05 [d]	[a]	0,05	10	50

I = Current made. The making current is expressed in d.c. or a.c. r.m.s. symmetrical values but it is understood that for a.c. the peak value of the asymmetrical current corresponding to the power-factor of that circuit may assume a higher value.

I_c = Current made and broken, expressed in d.c. or a.c. r.m.s. symmetrical values.

I_e = Rated operational current.

U = Applied voltage.

U_r = Power frequency or d.c. recovery voltage.

U_e = Rated operational voltage.

cos ϕ = Power-factor of test circuit.

L/R = Time-constant of test circuit.

[a] cos ϕ = 0,45 for $I_e \leq 100$ A, 0,35 for $I_e > 100$ A.

[b] Time may be less than 0,05 s provided that contacts are allowed to become properly seated before re-opening.

[c] See Table A.3.

[d] For U/U_e a tolerance of ±20 % is accepted.

[e] The make conditions shall also be verified but may be combined with the make and break test if agreed by the manufacturer. The making current multiples are to be as shown for I/I_e and the breaking current as shown for I_c/I_e. The off-time is to be taken from Table A.3.

[f] Twenty-five operating cycles with one polarity and twenty-five operating cycles with reverse polarity.

Table A.3 – Relationship between current broken I_c and off-time for the verification of the rated making and breaking capacities

Current broken I_c A	Off-time s
$I_c \leq 100$	10
$100 < I_c \leq 200$	20
$200 < I_c \leq 300$	30
$300 < I_c \leq 400$	40
$400 < I_c \leq 600$	60
$600 < I_c \leq 800$	80
$800 < I_c \leq 1\,000$	100
$1\,000 < I_c \leq 1\,300$	140
$1\,300 < I_c \leq 1\,600$	180
$1\,600 < I_c$	240

The values of off-time may be reduced if agreed by the manufacturer.

A.4 Operational performance

Subclause 7.2.4.2 of IEC 60947-1 applies with the following additions.

Equipment shall be capable of making and breaking currents without failure under the conventional conditions stated in Table A.4 for the required utilization categories and the number of operations indicated therein.

Table A.4 – Operational performance – Conditions for making and breaking corresponding to several utilization categories

Utilization category	Make and break conditions					
	I_c/I_e	U_r/U_e	cos ϕ	On-time s [b]	Off-time s	Number of operating cycles
AC-2	2,0	1,05	0,65	0,05	[c]	6 000
AC-3	2,0	1,05	[a]	0,05	[c]	6 000
AC-4	6,0	1,05	[a]	0,05	[c]	6 000
			L/R ms			
DC-3	2,5	1,05	2,0	0,05	[c]	6 000 [d]
DC-5	2,5	1,05	7,5	0,05	[c]	6 000 [d]

I_c = Current made or broken. The making current is expressed in d.c. or a.c. r.m.s. symmetrical values but it is understood that the actual value will be the peak value corresponding to the power-factor of the circuit.

I_e = Rated operational current.

U_r = Power frequency or d.c. recovery voltage.

U_e = Rated operational voltage.

[a] cos ϕ = 0,45 for $I_e \leq 100$ A, 0,35 for $I_e > 100$ A.

[b] Time may be less than 0,05 s provided that contacts are allowed to become properly seated before re-opening.

[c] These off-times shall be not greater than the values specified in Table A.3.

[d] 3 000 operating cycles with one polarity and 3 000 operating cycles with reverse polarity.

A.5 Mechanical durability

Subclause 7.2.4.3.1 of IEC 60947-1 applies with the following addition.

The preferred numbers of no-load operating cycles expressed in millions are

0,001 – 0,003 – 0,01 – 0,03 – 0,1 – 0,3 and 1.

If no mechanical endurance is stated by the manufacturer, a class of intermittent duty implies a minimum mechanical endurance corresponding to 8 000 h of operation at the highest corresponding frequency of operating cycles.

A.6 Electrical durability

Subclause 7.2.4.3.2 of IEC 60947-1 applies with the following addition.

The total number of on-load operating cycles shall be as declared by the manufacturer.

A.7 Verification of making and breaking capacities

See 8.3.3.3 except that the test values shall be in accordance with Tables A.2 and A.3.

With the agreement of the manufacturer, the tests of A.7 and A.8 may be conducted on the same sample.

A.8 Operational performance test

See 8.3.4.1 except that the test conditions shall be in accordance with Table A.4.

With the agreement of the manufacturer, the tests of A.7 and A.8 may be conducted on the same sample.

A.9 Special tests

Resistance to mechanical and/or electrical wear is demonstrated by the operational performance test detailed in A.8.

Where abnormal service conditions are expected (see also note to 7.2.4.3 of IEC 60947-1) the following tests may be necessary.

A.9.1 Mechanical durability test

A.9.1.1 Condition of the equipment for tests

The equipment shall be installed as for normal service; in particular, the conductors shall be connected in the same manner as for normal use.

During the test there shall be no voltage or current in the main circuit. The equipment may be lubricated before the test if lubrication is prescribed in normal service.

A.9.1.2 Operating conditions

The equipment shall be operated as in normal service.

A.9.1.3 Test procedure

a) The tests are carried out at the frequency of operations corresponding to the class of intermittent duty. However, if the manufacturer considers that the equipment can satisfy the required conditions when using a higher frequency of operations, he may do so.

b) The number of operating cycles to be carried out shall be not less than the number of no-load operating cycles stated by the manufacturer.

c) After each tenth of the total number of operations has been carried out, it is permissible before carrying on with the test

- to clean the whole equipment without dismantling;
- to lubricate parts for which lubrication is prescribed by the manufacturer for normal service;
- to adjust the travel and the pressure of the contacts if the design of the equipment enables this to be done.

d) This maintenance work shall not include any replacement of parts.

A.9.1.4 Results to be obtained

Following the tests of mechanical durability, the equipment shall still be capable of complying with the normal operating conditions at room temperature. There shall be no loosening of the parts used for connecting the conductors.

A.9.2 Electrical durability test

With respect to its resistance to electrical wear, an equipment is, by convention, characterized by the number of on-load operating cycles, corresponding to the different utilization categories given in Table A.5 which can be made without repair or replacement.

In all cases, the speed and number of operating cycles shall be chosen by the manufacturer.

The tests shall be taken as valid if the values recorded in the test report differ from the values specified only within the tolerances stated in 8.3.2.2.2 of IEC 60947-1.

Tests shall be carried out with the equipment under the appropriate conditions of A.9.1.1 and A.9.1.2 using the test procedure, where applicable, of A.9.1.3, except that replacement of contacts is not permitted.

After the test, the equipment shall fulfil the normal operating conditions specified in 8.3.3.2 and withstand a dielectric test voltage of twice the rated operational voltage U_e, but not less than 1 000 V, applied only as specified in 8.3.3.4.1, item 4) b), of IEC 60947-1.

Table A.5 – Verification of the number of on-load operating cycles – Conditions for making and breaking corresponding to several utilization categories

Utilization category	Values of the rated operational current	Make			Break		
		I/I_e	U/U_e	cos ϕ [a]	I_c/I_e	U_r/U_e	cos ϕ [a]
AC-2	All values	2,5	1	0,65	2,5	1	0,65
AC-3	$I_e \leq 17A$	6	1	0,65	1	0,17	0,65
	$I_e > 17A$	6	1	0,35	1	0,17	0,35
AC-4	$I_e \leq 17A$	6	1	0,65	6	1	0,65
	$I_e > 17A$	6	1	0,35	6	1	0,35
		I/I_e	U/U_e	L/R [b] ms	I_c/I_e	U_r/U_e	L/R [b] ms
DC-3	All values	2,5	1	2	2,5	1	2
DC-5	All values	2,5	1	7,5	2,5	1	7,5

I_e = Rated operational current.

U_e = Rated operational voltage.

I = Current made. In a.c. the conditions for making are expressed in r.m.s. symmetrical values but it is understood that the peak value of asymmetrical current, corresponding the power-factor of the circuit, may assume a higher value.

U = Applied voltage.

U_r = Power frequency and d.c. recovery voltage.

I_c = Current broken.

[a] Tolerance for cos ϕ: ±0,05.

[b] Tolerance for L/R : ±15 %.

Annex B
(informative)

Items subject to agreement between manufacturer and user

NOTE For the purpose of this annex
- "agreement" is used in a very wide sense;
- "user" includes testing stations.

Annex J of IEC 60947-1 applies with regard to clauses and subclauses of this standard, with the following additions.

Clause or subclause number of this standard	Item
4.4	Switching of capacitors or of tungsten filament lamps
7.1.6.1 note	Operating time of auxiliary contacts provided for interlocking
7.2.4.2 and Table 4	Increase of the operating rate for the verification of the operational performance
8.3.3.3.1	Time interval greater than 30 s ± 10 s between close-open cycles for making and breaking capacity test of equipment of I_{th} > 400 A
	For categories AC-23A and AC-23B testing of making and breaking capacities by make cycles at 10 I_e followed by the same number of make-break cycles at 8 I_e
8.3.3.3.3	Verification of making and breaking capacities for utilization categories DC-22 and DC-23: replacement of the load of the test circuit by a motor
8.3.5.2.3	AC test circuit calibration for the short-circuit making capacity test in the case of d.c. equipment
Annex A A.3	Utilization categories other than those listed in Table A.2
Table A.1	Switching of rotor circuits, capacitors or tungsten filament lamps
A.7	Verification of making and breaking capacities
A.8	Operational performance test

Annex C
(normative)

Single pole operated three pole switches

C.1 General

All requirements of this standard apply except where modified by the following.

The test requirements according to this standard for verification of making and breaking capacities, operational performance and conditional short-circuit withstand, apply to devices with poles operated simultaneously. They are therefore not suitable for three-phase switches operated pole by pole.

If a three pole operated switch of fundamentally the same design has been successfully tested, it is deemed to satisfy the requirements of this annex for an individually operated three pole device.

Important characteristics of three-phase switches operated pole by pole and relevant for the above mentioned tests are as follows:

- The three poles are operated individually and are positioned adjacent to each other.

  The three phases can typically be situated beside each other (horizontal version, see Figure C.1 b)) or below each other (vertical version, see Figure C.1 a)).
- The sequence of operation of the poles is at the discretion of a skilled operator.
- The design of the individual poles shall be fundamentally the same.

The position of the device under test shall be defined by the manufacturer and stated in the test report.

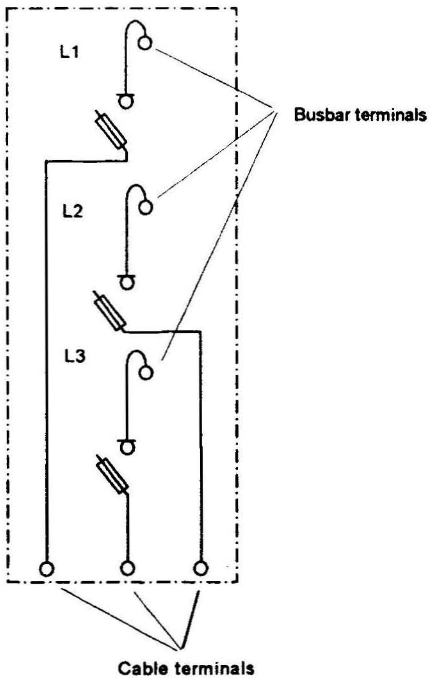


Figure C.1 a) – Vertical version

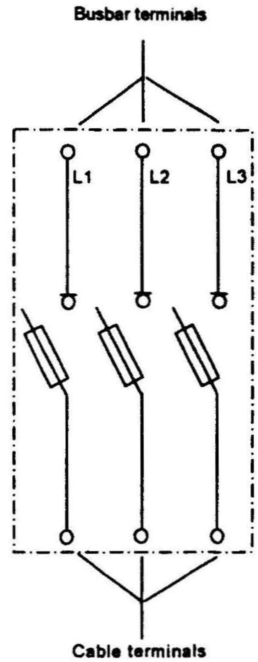


Figure C.1 b) – Horizontal version

Figure C.1 – Typical arrangements

C.2 Tests

When testing single pole operated three pole switches, the relevant test sequences of Table 10 shall be applied with the following identified tests, modified in accordance with Clause C.3:

– 8.3.3.3 Making and breaking capacities of test sequence I;

– 8.3.4.1 Operational performance of test sequence II;

– 8.3.6.2 Fuse protected short-circuit withstand. b) Making of test sequence IV.

C.3 Test set-up and sequence

C.3.1 Making and breaking capacities (8.3.3.3.1) and operational performance (8.3.4.1.1)

Test 1: With L1 and L2 closed, L3 is subjected to the required make-break operation cycle.

Test 2: With L2 closed and L3 open, L1 is subjected to the required make-break operation cycle.

All tests shall be performed in a three-phase test circuit according to Figure 5 of IEC 60947-1.

C.3.2 Fuse protected short-circuit test (8.3.6.2)

For the making test of the fuse-switch, the following test shall be applied.

With L1 open and L2 closed, L3 is subjected to the required make operation cycle. The test shall be performed in a three-phase test circuit according to Figure 11 of IEC 60947-1.

C.4 Condition of equipment after tests

The equipment shall comply with the relevant clauses of 8.3.3.3.6, 8.3.4.1.6 and 8.3.5.2.6.

C.5 Instructions for use

The manufacturer shall include within the product literature the following statement.

These devices are intended for power distribution systems where switching and/or isolation of an individual phase may be necessary and shall not be used for the switching of the primary circuit of three-phase equipment.

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